

Chapter 1

Gases and the Zeroth Law of Thermodynamics

- 1.2.** A system is any part of the universe under observation. The “surroundings” includes everything else in the universe. Consider a solution calorimeter in which two aqueous solutions are mixed and temperature changes are recorded. In this case the solutes (reactants and products) would be considered the “system”. The water, calorimeter, and rest of the lab and world would be the “surroundings”.
- 1.4.** (a) $12.56 \text{ L} \times \frac{1000 \text{ mL}}{1 \text{ L}} \times \frac{1 \text{ cm}^3}{1 \text{ mL}} = 12,560 \text{ cm}^3 = 1.256 \times 10^4 \text{ cm}^3$
(b) $45^\circ\text{C} + 273.15 = 318 \text{ K}$
(c) $1.055 \text{ atm} \times \frac{1.01325 \text{ bar}}{1 \text{ atm}} \times \frac{100,000 \text{ Pa}}{1 \text{ bar}} = 1.069 \times 10^5 \text{ Pa}$
(d) $1233 \text{ mmHg} \times \frac{1 \text{ torr}}{1 \text{ mmHg}} \times \frac{1 \text{ atm}}{760 \text{ torr}} \times \frac{1.01325 \text{ bar}}{1 \text{ atm}} = 1.644 \text{ bar}$
(e) $125 \text{ mL} \times \frac{1 \text{ cm}^3}{1 \text{ mL}} = 125 \text{ cm}^3$
(f) $4.2 \text{ K} - 273.15 = -269.0^\circ\text{C}$
(g) $25750 \text{ Pa} \times \frac{1 \text{ bar}}{100,000 \text{ Pa}} = 0.2575 \text{ bar}$
- 1.6.** $p_{\text{tot}} = p_{\text{atmosph}} + \rho hg$, where ρhg correspond to the pressure exerted by the liquid
 $p_{\text{tot}} - p_{\text{atmosph}} = \rho hg = (1.0 \times 10^3 \text{ kg/m}^3)(0.23 \text{ m})(9.80 \text{ m/s}^2) = 2254 \text{ N/m}^2 = 2.3 \times 10^3 \text{ Pa}$
- 1.8.** In terms of the zeroth law of thermodynamics, heat will flow from the (hot) burner or flame on the stove into the (cold) water, which gets hotter. Then heat will move from the hot water into the (colder) egg.
- 1.10.** For this sample of gas under these conditions, $F(T) = 2.97 \text{ L} \times 0.0553 \text{ atm} = 0.164 \text{ L} \cdot \text{atm}$. If the pressure were increased to 1.00 atm: $0.164 \text{ L} \cdot \text{atm} = (1.00 \text{ atm}) \times V$; therefore $V = 0.164 \text{ L}$.
- 1.12.** $V = R \cdot \frac{nT}{p}$, which rearranges to $R = \frac{pV}{nT}$.
Therefore: $R = \frac{(2.66 \text{ bar})(27.5 \text{ L})}{(1.887 \text{ mol})(466.9 \text{ K})} = 0.0830 \frac{\text{L} \cdot \text{bar}}{\text{mol} \cdot \text{K}}$

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